

MACROMETRIC CHANGES IN THE MAKEUP OF THE HUMAN
BODY IN HYPODYNAMIA

A. G. Zhdanova]

(NASA-TT-F-15252) MACROMETRIC CHANGES IN
THE MAKEUP OF THE HUMAN BODY IN
HYPODYNAMIA (Techtran Corp) 11 p HC

N74-13810

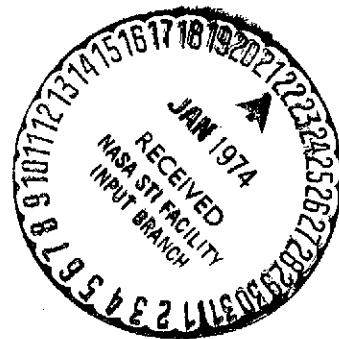
\$3.00

CSC 06P

Unclass

63/04 26043

Translation of: "Makrometricheskiye Izmeneniya
Sostava Tela Cheloveka pri Gipodinamii," Arkhiv Anatomii,
Gistologii i Embriologii, Vol. 49, No. 12, 1965, pp. 29-34.



1. Report No. NASA TT F-15,252	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle MACROMETRIC CHANGES IN THE MAKEUP OF THE HUMAN BODY IN HYPODYNAMIA		5. Report Date JANUARY 1973	
		6. Performing Organization Code	
7. Author(s) A. G. Zhdanova		8. Performing Organization Report No.	
		10. Work Unit No.	
9. Performing Organization Name and Address Techtran Corporation P.O. Box 729 Glen Burnie, Maryland 21061		11. Contract or Grant No. NASw-2485	
		13. Type of Report and Period Covered Translation	
12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, D. C. 20546		14. Sponsoring Agency Code	
15. Supplementary Notes Translation of: "Makrometricheskiye Izmeneniya Sostava Tela Cheloveka pri Gipodinamii," Arkhiv. Anatomii, Gistologii i Embriologii, Vol. 49, No. 12, 1965, pp. 29-34.			
16. Abstract The author studied changes in human organism produced by "ground", "water" 2-, 5-, 7- and 10-day long hypodynamia, affecting general weight of the body, its fat and nonfat components, specific weight of the body. The investigation was carried out on 18 subjects. The data obtained were compared with earlier findings on functional shifts, occurring in the organism under the similar conditions, and enabled the author to suggest that hypodynamia, developing during long-lasting stay in the aircraft and resulting in a relative atrophy of the skeletal muscles, may be of a considerable hindrance for the organism, especially at the moment of landing, when the nervous-muscular activity begins to be activated and later on, with readaptation to the conditions of the ground existence. Consequently, preservation and maintenance of adaptive reactions of the muscular and other systems to the effect of gravity are an important prerequisite for a successful issue of durable flights connected with forced staying of man in conditions of hypodynamia and weightlessness and for return to the conditions of earth gravitation.			
17. Key Words (Selected by Author(s))		18. Distribution Statement Unclassified-Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 10 11	22. Price 300

MACROMETRIC CHANGES IN THE MAKEUP OF THE HUMAN
BODY IN HYPODYNAMIA¹A. G. Zhdanova²

In Soviet and foreign literature, a large number of studies have been devoted to physiological, biochemical and morphological changes of the muscles of man and animals kept under various conditions of motor activity (A. K. Koveshnikov, 1951, 1954, 1956; V. Smoldaka, 1959; R. V. Chagovets, 1951; N. N. Yakovlev, 1959; Ye. S. Yakovleva, 1954, and others).

The studies which pertain to the effect of long term muscular inactivity, i.e., hypodynamia, to the work capacity of man, and to the physiology and pathology of the internal organs were published by Deitrick, Whedon, and Shorr (1948), Taylor, Henschel, Brozek and Keys (1949), Ogle (1957), Bartlett (1959), R. M. Mogendovich (1957, 1961), B. G. Bugrov et al. (1958), V. P. Kolychev (1960), Graveline, Balke, McKensie and Hartman (1961), A. V. Korobkov (1961), Graveline (1962), A. V. Korobkov, N. A. Matyushina, S. A. Razumov (1962), T. T. Dzhamgarov (1962), Yu. V. Vanyushina (1963), M. A. Gerd (1963), L. I. Kakurin et al. (1963), A. L. Myasnikov et al. (1963), and by N. Ye. Panferova (1963).

However, the effect of hypodynamia on the macrometric indices of the body composition remains inadequately clarified; i.e., the effect of hypodynamia on the ratio of fat and nonfat (primarily "muscular") components of the human body's composition. These fraction indices of total weight are significantly more accurate than fluctuations in total body weight and reflect changes in the physical condition of man under the influence of changes in the conditions

¹The study was conducted with a collective of associates at the functional Anthropology Group of the Central Scientific Research Institute of Physical Therapy under the scientific and organizational supervision of G. A. Demidov and V. I. Slesarev.

²Department of Anatomy (Chief-Meritorious Scientific Fellow of the RSFSR, Doctor of Medical Sciences, Professor M. F. Ivanitskiy) of the State Central Order of Lenin Institute of Physical Therapy [Translator's Note: literally Physical Culture].

*Numbers in the margin indicate pagination in the foreign text.

of work, nutrition, emotional state, etc. The weight of the human body in air in the usual rhythm of life, just as is the case with the basal metabolism, is distinguished by relative stability. From a morphological and functional point of view, fluctuations in body weight and in the basal metabolism reflect a certain directivity of the metabolic processes. In the available literature, there are no data concerning how rapidly macrometric changes in the *in vivo* composition of the human body occur, or to what degree they are pronounced, or how they can influence the capacity of man to control aircraft; this pertains to those macrometric changes related to the influence of hypodynamia. Does atrophy of the muscular masses occur in long term flights which are accompanied by weightlessness and immobility, and does the atrophy-related loss of muscular strength also occur? Does the fat component of the composition of the human body remain unchanged or does it sharply increase, creating additional undesirable stress on the cardiovascular system, etc.? In connection with this, we set for ourselves the goal of tracing the influence of limited mobility of various duration on the composition of the human body according to its specific gravity.

Determination of specific gravity was made by means of hydrostatic weighing. Men 20-25 years of age were subjected to investigation. In all, 18 experiments were conducted having the following durations: 2, 5, 7, and 10 days. One series of experiments — 10 experiments ("ground" hypodynamia) — was conducted on the subjects in a posture of maximum weakening of the human supportive and motor apparatus. The second series — 8 experiments — was carried out on subjects who were located in a suspended state in a basin containing water ("water" hypodynamia). /30

In our observations, change in the overall weight of the body among the subjects had an extremely varied character — a decrease or increase in weight or stability with respect to weight (Table 1). Therefore, these changes should not be considered the result of hypodynamia. Changes in weight dependent upon the duration of hypodynamia indicate its decrease, particularly after 5 or 7 day hypodynamia — by 0.950 and 1.450 g. In most of the subjects, specific gravity decreased. A particularly significant difference was observed in the 2 day (Table 2) and 5 day hypodynamia (Table 3). An even more significant

decrease in the indices of specific gravity exists in the 7 day (Table 4) and 10 day periods of hypodynamia.

TABLE 1. CHANGE IN TOTAL BODY WEIGHT, FAT AND NONFAT COMPONENTS OF THE BODY UNDER THE INFLUENCE OF "GROUND" AND "WATER" HYPODYNAMIA

Type of Hypodynamia	No. of Cases	Increase	Decrease	Without Change
Change in Total Body Weight (kg)				
Ground	10	5	0	5
Water	8	2	1	5
Total	18	7	1	10
Change in Fat Components (kg)				
Ground	10	10	—	—
Water	8	7	—	1
Total	18	17	—	1
Change in Nonfat Components (kg)				
Ground	10	2	—	8
Water	8	—	—	8
Total	18	2	—	16

Fractioning of weight detected change in the composition of the body during hypodynamia toward an increase in fat and a decrease in the nonfat component (Table 1-5). A general increase in the amount of fat occurs even in hypodynamia of short duration (2 days), on the average by 250 g, over 7 days by 1030 g, over 10 days by 1440 g, etc. A decrease in the nonfat component occurred as the result of a decrease in the amount of water in the organism. With comparatively long term hypodynamia (5, 10 or more days), persistent disorders of the metabolic processes in the muscular tissue were also detected and were accompanied not only by a decrease in the water component, but also by a decrease in the "muscular" component. The essence of the changes which occurred under the influence of hypodynamia has up to this point been far from adequately studied.

Our data on the macrometric changes in the composition of the body ("muscular", fat, and water components) indicate the development of "adiposity",

atrophic direction of the metabolic processes in the muscular tissue, and "dehydration" in most cases of hypodynamia of varied duration. A sign of the development of relative "adiposity" (the term is used by us arbitrarily) is an increase in the fat component as the result of decreased muscular activity. /33
Loss of function also leads to morphological changes — to the accumulation of a quantity of fat, and possibly, during very long term hypodynamia, also to fibrose adiposity type degeneration of the active muscles. An increase in the store of fat is related to an adequate mobilization of the fat during muscular "inactivity".

Artificially creating functional inactivity (hypodynamia) is apparently a factor which can exert an influence on the development of a unique parabiologic process in the muscles, i.e., phenomena which are near in character to denervation (A. V. Zhirmunskiy, 1958). Excluding motor innervation leads to the appearance of atrophic changes in the muscles and to the development in the muscles of contractures, to slowing of the process of regeneration, etc. (P. M. zubenko and A. D. Reva, 1947; O. V. Nedrigaylova, 1948; A. B. Gandel'sman, 1952; N. A. Galitskaya, 1953; N. A. Kutsenko and G. A. Nechayeva, 1953; S. M. Vershchagin, Ye. K. Zhukov and Ye. M. Lebedeva, 1954; O. V. Parushkin, 1955). A qualitative change in the muscular component under the influence of hypodynamia characterizes an atrophic trend in the metabolism in the muscle tissue, during which the deterioration of protein is not compensated for by protein synthesis. The deterioration of the mass of the muscular component is accompanied by a decrease in the level of activity of certain enzymatic systems and functional capacities of the organism, as well as by change in the structure of the muscle tissue (R. V. Chagovets, 1957). According to the data of P. Z. Gud' (1963), among animals in hypodynamia, dystrophy of the muscle fibers occurs. All of the changes in the nonfat component of the body's composition which exist in hypodynamia we relate to the mass of skeletal musculature and the water component of the organism, a decrease in which is frequently related not only to change in the amount of extracellular and intracellular fluid of the organism, but also to a disorder in the activity of the cardiovascular system. Morphological changes in the composition of the body which emerge under the influence of hypodynamia are accompanied by a decrease in the strength indices of the

skeletal musculature (polydynamometry), and by disorders of the motor coordination, etc. (A. G. Zhdanova, G. A. Demidov, V. I. Slesarev, 1963).

TABLE 2. RESULTS OF FRACTIONING WEIGHT OF SUBJECTS KEPT UNDER THE ACTION OF A 2 DAY LONG PERIOD OF HYPODYNAMIA

No. of Subjects	Total Weight		Change in total weight (kg)	Specific gravity g/cm^3		Change in specific gravity (g/cm^3)	Fat component (kg)		Change in fat component (kg)	Nonfat component (kg)		Change in nonfat component (kg)	Type of hypodynamia
	Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		
1	63,900	64,900	+1,000	1,0815	1,0804	-0,0011	4,500	4,800	+0,300	59,400	60,100	+0,700	Ground
2	62,750	62,700	-0,050	1,0673	1,0643	-0,0030	7,700	8,350	+0,650	55,050	54,350	-0,700	Water
3	64,850	66,350	+1,500	1,0630	1,0518	-0,0112	9,100	10,900	+1,800	56,250	55,950	-0,300	,
4	60,150	60,150	0,000	1,0630	1,0595	-0,0035	8,250	9,150	+0,900	51,900	51,000	-0,900	,
5	60,450	59,450	-1,000	1,0624	1,0569	-0,0055	8,500	9,600	+1,100	51,950	49,850	-2,100	,

Commas indicate decimal points.

TABLE 3. RESULTS OF FRACTIONING THE WEIGHT OF SUBJECTS KEPT UNDER THE ACTION OF A 5 DAY LONG PERIOD OF HYPODYNAMIA

No. of Subjects	Total Weight		Change in total weight (kg)	Specific gravity g/cm^3		Change in specific gravity (g/cm^3)	Fat component (kg)		Change in fat component (kg)	Nonfat component (kg)		Change in nonfat component (kg)	Type of hypodynamia
	Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		
1	90,400	86,700	3,700	1,0776	1,0740	-0,0036	8,000	8,500	+0,500	82,400	78,200	-4,200	Ground
2	68,750	66,300	-2,450	1,0863	1,0846	-0,0017	3,700	4,000	+0,300	65,050	62,300	-2,750	,
3	67,600	67,950	+0,350	1,0613	1,0577	-0,0036	9,800	10,800	+1,000	57,800	57,150	-0,650	,
4	65,200	64,800	-0,400	1,0622	1,0574	-0,0048	9,250	10,500	+1,250	56,150	54,500	-1,650	Water
5	69,150	70,600	+1,450	1,0782	1,0730	-0,0052	7,000	8,400	+1,400	62,150	62,200	+0,050	Ground

Commas indicate decimal points.

The data obtained by us on the influence of experimental hypodynamia on the composition of the body make it possible to hypothesize that hypodynamia during a long term stay of man in flying devices, causing phenomena of relative atrophy of the skeletal muscles, can present significant difficulties for the

organism. Particularly at the moment of transition to activation of the neuromuscular activity on landing, and subsequently, during readaptation to conditions of terrestrial existence. Therefore, an important condition of successfully concluding long term flights connected with a forced stay of man under conditions of hypodynamia and weightlessness and his return to conditions of terrestrial gravitation is maintenance and preservation of the adaptive reactions of the muscular and other systems to the effect of the force of gravity.

TABLE 4. RESULTS OF FRACTIONING THE WEIGHT OF SUBJECTS KEPT UNDER THE ACTION OF A 7 DAY LONG PERIOD OF HYPODYNAMIA

No. of Subjects	Total Weight		Change in total weight (kg)	Specific gravity g/cm^3		Change in specific gravity (g/cm^3)	Fat component (kg)		Change in fat component (kg)	Nonfat component (kg)		Change in non-fat component (kg)	Type of hypodynamia
	Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		
1	58,500	59,500	+1,000	1,0846	1,0760	-0,0086	3,500	5,400	+1,900	55,000	54,100	-0,900	Ground
2	64,950	63,100	-1,850	1,0714	1,0670	-0,0044	7,000	7,800	+0,800	57,950	55,300	-2,650	•
3	65,950	63,900	-2,050	1,0750	1,0723	-0,0027	6,300	6,700	+0,400	59,650	57,200	-2,450	•
4	62,600	59,250	-3,350	1,0685	1,0679	-0,0006	7,450	7,200	-0,250	55,100	52,000	-3,100	Water

Commas indicate decimal points.

TABLE 5. RESULTS OF FRACTIONING THE WEIGHT OF SUBJECTS KEPT UNDER THE ACTION OF A 10 DAY LONG PERIOD OF HYPODYNAMIA

No. of Subjects	Total Weight		Change in total weight (kg)	Specific gravity g/cm^3		Change in specific gravity (g/cm^3)	Fat component (kg)		Change in fat component (kg)	Nonfat component (kg)		Change in non-fat component (kg)	Type of hypodynamia
	Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		Before the experiment	After the experiment		
1	64,800	65,200	+0,400	1,0622	1,0560	-0,0062	9,250	10,800	+1,550	55,950	54,800	-1,150	Ground
2	68,350	69,850	+1,500	1,0865	1,0775	-0,0090	4,100	7,200	+3,100	64,250	62,650	-1,600	Water
3	65,550	64,150	-1,400	1,0718	1,0714	-0,0004	6,300	6,900	+0,600	59,250	57,250	-2,000	Ground
4	66,400	65,200	-1,200	1,0718	1,0706	-0,0012	7,000	7,500	+0,500	59,400	57,700	-1,700	Water

Commas indicate decimal points.

REFERENCES

1. Bartlett Jr., R. G., *J. Appl. Physiol.*, Vol. 14, No. 1, 1959.
2. Bugrov, B. G. et al., "Investigations of the Vital Activity of Animals During Flights in the Nonpressurized Cabin of a Rocket to an Altitude of 110 km," in the collection: *Predvaritel'nyye itogi nauchnykh issledovaniy s pomoshch'yu pervykh sovestkikh iskusstvennykh sputnikov zemli i raket* [Preliminary Results of Scientific Investigations Carried Out By the Aid of the First Soviet Artificial Satellites of the Earth and of Rockets], Moscow, Academy of Sciences, USSR, 1958.
3. Chavogets, R. V., *Ukr. biokhim. zhurn.*, Vol. 23, 1951;
"Principle Types of Directivity of the Metabolism in the Skeletal Muscles and Their Regulation," in the book: *Tr. Kieyvs. in-ta fizkul'tury* [Transactions of the Kiev Institute of Physical Culture], Vol. 2, 1957.
4. Deitrick, J. E., G. D. Whedon and E. Schorr, *Am. J. Med.*, Vol. 3, pp. 3-36, 1948.
5. Dzhangarov, T. T., "Investigation of the Working Capacity and Condition of the Human Organism under Conditions of Long Term Isolation In a Sealed Chamber Dependent Upon the Regime of Motor Activity," *Tr. fakul'teta, XXX, KVIFKiS pri GP OIFK im P. F. Lesgafta* [Abstracts of the Department, XXX, KVIFKiS at GP OIFK imeni P. F. Lesgafta], Leningrad, 1962.
6. Galitskaya, N. A., *Fiziol. zhurn. SSSR*, Vol. 39, No. 6, 1953.
7. Gandel'sman, A. B., *Dvigatel'naya funktsiya i immobilizatsiya* [Motor Function and Immobilization], Author's abstract of a dissertation, Leningrad, 1952.
8. Gerd, M. A., "Data on the Behavior and Certain Functions of the Human Organism with Respect to People Who Are Located Under Conditions of Limited Mobility," in the book: *Aviatsionnaya i Kosmicheskaya Meditsina* [Aviation and Space Medicine], 1963.
9. Graveline, D. E., *Aerospace Med.*, Vol. 33, p. 297, 1962.
10. Graveline, D. E., B. Balke, R. E. McKensie and B. Hartman, *Aerospace Med.*, Vol. 32, No. 5, 1961.
11. Gudzh', P. Z., *Arkh. Anat.*, Vol. 14, No. 7, 1963.
12. Kakurin, L. I. et al., "The Effect of Hypokinesia on Certain Indices of the Working Capacity and Functions of Respiration of Man," in the book: *Aviatsionnaya i Kosmicheskaya Meditsina* [Aviation and Space Medicine], Moscow, 1963.
13. Kolychev, V. P., "The Influence of Static Muscular Work, Immobilization of the Extremities and Vibration on Circulation and Respiration Among Healthy Dogs," *SB. Nauchnykh Trudov Permsk. med. in-ta*, No. 31, 1960.
14. Korobkov, A. V., "Achieving Work Capacity Under Conditions of Limited Mobility (Relative Adynamia) — An Important Task of Physical Training," in the collection: *Materialy Nauchnoy Konferentsii (Chelovek Usloviyakh Adinamii i Izolyatsiya)* [Materials of a Scientific Conference (Man Under Conditions of Adynamia and Isolation)], Leningrad, 1961.
15. Korobkov, A. V., N. A. Matyushkina and S. A. Razumov, "Physiological Analysis of a Four Hour Period of Hypodynamia," *Tr. fak-ta, V, XXX, KVIFKiS pri GDOIFK im P. F. Lesgafta* [Abstracts of the Department in the XXX, KVIFKiS of the GDOIFK imeni P. F. Lesgafta], Leningrad, 1962.
16. Koveshnikova, A. K., "Changes in the Skeleto-Muscular System and the Motor Innervation of the Skeletal Muscles Under the Influence of Various

- Conditions of Activity," in the collection: *Problemy funktsional'noy morfolologii dvigatel'nogo apparata* [Problems of Functional Morphology of Motor Apparatus], Leningrad, "Medgiz" Press, 1956;
- "The Influence of Altered Muscular Activity on the Motor Nerve Endings," *Izv. yest.-nauchn. in-ta im. A. E. Lesgafta*, Moscow, Vol. XXVI, 1954;
- "The Effect of Altered Stasis of an Animal on the Structure of its Muscles and Skeleton," *Izv. APN SSSR*, Moscow, Vol. 35, 1951.
17. Kutsenko, N. A. and G. A. Nechayeva, *Fiziol. Zhurn. SSSR*, Vol. 39, No. 6, 1953.
 18. Maysnikov, A. L. et al., "The Problem of the Influence of Long Term Hypokinesia on the Human Circulation," in the book: *Aviatsionnaya i kosmicheskaya Meditsina* [Aviation and Space Medicine], 1963.
 19. Mogendovich, M. R., *Reflektornoye Vzaimodeystviye Lokomotornykh i Vistseral'nykh Sistem* [Reflex Interaction of the Locomotor and Viseral Systems], "Medgiz" Press, 1957;
 "Hypokinesis As a Pathological Factor of the Internal Organs (Experimental-Physiological Basis)," in the book: *Fiziologiya i Patologiya Motorno-vistseral'nykh Refleksov* [The Physiology and Pathology of Motor-Viseral Reflexes], Perm', 3rd edition, 1961.
 20. Nedrigaylova, O. V., "Experimental Data on the Problem of the Mechanogenesis of Akinematic Contractures," *Uch. Zap. Ukr. in-ta Ortopedii i Travmatologii im. Prof. M. I. Sitenko* [Scientific Notes of the Professor M. I. Sitenko Memorial Ukrainian Institute of Orthopedics and Traumatology], Khar'kov, 1948.
 21. Ogle, C., *United States Armed Forces Med. J.*, Vol. 11, 1957.
 22. Panferova, N. Ye., "Materials for a Study of the Diurnal Regime of Functions Under Conditions of Limited Mobility", in the book: *Aviatsionnaya i Kosmicheskaya Meditsina* [Aviation and Space Medicine], Moscow, 1963.
 23. Smoldaka, V., "Morphological Changes in the Organism of the Trained Sportsmen," *Tr. XII Yubil. Mezhdunar. kongr. sport. med.* [Transactions of the 12th Jubilee International Congress of Sports Medicine], Moscow, "Medgiz" Press, 1959.
 24. Tarushkin, O. V., *Electrofiziologicheskoye Issledovaniye Mekhanizmov Immobilizatsionnykh Myshechnykh Gipertoniy i Kontraktur* [Electrophysiology Investigation of the Mechanisms of Muscle Immobilizing Hypertonies and Contractures], Authors Abstract of a Dissertation, Leningrad, 1955.
 25. Taylor, H. L., A. Henschel, J. Brozck and A. Keys, *J. Appl. Physiol.*, Vol. 2, p. 223, 1949.
 26. Vanyushina, Yu. V., "Functional Changes in the Cardiovascular System Following Exposure to Hypodynamia," in the book: *Aviatsionnaya i Kosmicheskaya Meditsina* [Aviation and Space Medicine], Moscow, 1963.
 27. Vereshchagin, S. M., Ye. K. Zhukov and Ye. M. Lebedeva, "Investigation of the Physiological Mechanisms of the Appearance of Pathological Contractures," *Tez. dokl. nauchn. sessii LGU za 1953-1954 gg. Sektsiya biol. nauk* [Abstracts of Reports of the Scientific Session of the Leningrad State University from 1953 to 1954. Biological Sciences Section], Vol. 88, Leningrad, 1954.
 28. Yakovleva, Ye. S., "Morphological Changes in the Transversostriated Muscular Fibers During Physical Work of Various Types," *Izv. yest.-nauchn. in-ta im. P. F. Lesgafta*, Vol. 26, 1954.

29. Yakovlev, N. N., "Biochemical Characteristics of Training," *Tr. XII Yubil. Mezhdunar. kongr. sport. med.* [Transactions of the 12th Jubilee International Congress of Sports Medicine], Moscow, "Medgiz" Press, 1959.
30. Zhdanova, A. G., G. A. Demidov and V. I. Slesarev, "The Effect of Hypodynamia on the Morphofunctional Characteristics of Man," in the collection: *Materialy k itogovoy nauchnoy sessii instituta za 1962 god* [Materials for a Summary Scientific Session of the Institute for the 1962 Period], Moscow, 1963.
31. Zhirmunskiy, A. V., "The Problem of the Parabiologic Nature of the Reaction of Skeletal Muscles of Mammals to Denervation," *Fiziol. zhurn. SSSR*, Vol. XLIV, No. 6, 1958.
32. Zubenko, P. M. and A. B. Reva, *Byull. eksper. biol.*, Vol. 23, No. 6, p. 416, 1947.

Translated for the National Aeronautics and Space Administration under Contract No. NASw-2485 by Techtran Corporation, P.O. Box 729, Glen Burnie, Maryland, 21061; translator, Samuel D. Blalock Jr.